Advanced Systems for Assessing the Performance of Regional Networks

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ABSTRACT

As studies are undertaken to collect information on factors affecting regional discrimination in various regions, it will be important to have available a tool for evaluating the performance of discriminants and the seismic networks being used. S-CUBED (under ARPA support) has developed an interactive computer system (called XNICE, for X windows program for Network Identification Capability Evaluation) for performing these assessments. We present detection and identification thresholds computed (under the ARPA contract) by XNICE for body and surface waves. We have focused on events occurring in Europe, Western U.S. and Tibet for which we have regional propagation data and previous regional discrimination studies. The propagation characteristics are calibrated to be compatible with observed magnitude-moment, distance decay rate and dispersion relations. We show identification results based on the ability of networks to determine location and depth, the ability to resolve spectral slopes of regional phases and the ability to find Ms:mb and Mw:ML ratios for earthquakes, overburied and normally buried explosions and quarry blasts. Under a new contract to DoE (which has not been initiated), we will extend both the capabilities and applications of the program beyond the scope of the current project. In particular, we will evaluate network (primarily GSETT stations) identification performance in regions that have been chosen for their relevance to monitoring a CTBT. The program will include an assessment of overall network performance and the performance of standard regional discriminants, as well as assessments of methodologies for extracting discrimination features, new developing discriminants and strategies for improving identification performance.

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OBJECTIVE

The goal of this research to be undertaken is to formulate and apply techniques for making statistical descriptions of the performance of the tasks of detecting, locating and identifying seismic sources. These methods are to be applied to existing seismic networks and identification procedures, or to modifications.

RESULTS OF PREVIOUS RESEARCH

For this conference, we present results of work done under a previous ARPA contract. The results include the following:

1. We have developed models for regional source and propagation mechanisms (Barker, et al., 1994). The models of regional phases include the effects of non-linear processes, in particular, spall. We use kinematic models of spall to incorporate the effects of mass movements associated with nuclear explosions and quarry blast charges. These spall movements change the source spectra, generally causing the measured slope above 1 Hz to increase. We use models of source spectra and the relative excitation of the sources to account for the differences in regional phase excitation for the various source types. We apply discriminants based on the spectral slopes from 1 Hz to 10 Hz of Lg, Pg and Lg/Pg to the events generated by XNICE. The models predict that spectral slopes for Lg, Pg and Lg/Pg are least for earthquakes, are greater for normally buried explosions and are greatest for quarry blasts. Spectral slopes of Lg are closer to earthquakes for overburied bombs, and can be indistinguishable at low magnitudes. These results are all consistent with numerous observations. We also show that network detection levels strongly influence these results.
2. We show global detection and identification thresholds for the Ms:mb and Lg spectral slope discriminants for proposed IDC stations. As a test of the XNICE program, we compare global detection contours with those from NetSim. As part of this exercise, a database of station characteristics and propagation parameters was established which the XNICE and NetSim programs share.
3. We show identification performance for source locations in central Europe for proposed alpha stations of the IDC networks and show the effects of including beta stations on identification thresholds. For these calculations, we focus on the Lg/P spectral ratio and Lg spectral slope discriminants.
4. We model the observations in Woods, et al., 1993, in which the ML:Mo discriminant for earthquakes and NTS explosions is investigated. We show that our regional models predict performance of this discriminant similar to the observations.

RECOMMENDATIONS AND FUTURE PLANS

The primary focus of future work will be the application of XNICE to regions of relevance to the CTBT. For the most part, these will be defined by the regions chosen for study which have recently been chosen for PL/AFOSR/DOE/AFTAC funding.